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# SUMMER CROPS for GREEN MANURE and SOIL IMPROVEMENT



Farmers' Bulletin No. 1750  
U. S. DEPARTMENT OF AGRICULTURE

**C**ROPS most popular for summer green manure and soil improvement are the legumes—alfalfa, red clover, soybeans, cowpeas, velvetbeans, sweetclover, crotalaria, and lespedeza. Many nonlegumes, however, are as suitable and widely used, particularly for such purposes as supplying organic matter to the soil and improving worn-out land.

Summer legumes, in mixed plantings with other crops and in rotations where they are used as hay, enrich the soil with nitrogen and, through the roots and stubble left in the soil, add organic matter.

Generally, summer crops should not be used exclusively for green manure but, for maximum economy, should be planted as one of the regular cash crops in a rotation.

This bulletin describes generally how to use summer crops for green manure and soil improvement and specifically how the various legumes and nonlegumes are used.

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Washington, D. C.

Issued September 1935  
Revised January 1947

# SUMMER CROPS FOR GREEN MANURE AND SOIL IMPROVEMENT

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**G**REEN-MANURE crops are grown more often in winter because summer is the season when most cash crops must be grown. Growing summer green-manure crops, however, is practical in rotations or in mixed plantings. This provides one of the most economical ways to maintain soil fertility, insure increased crop yields, and improve the soil.

## CROPS COMMONLY USED

The summer crops commonly used for green manure and soil improvement are such legumes as alfalfa, red clover, soybeans, cowpeas, velvetbeans, sweetclover, crotalaria, and lespedeza. Other crops, both legumes and nonlegumes, are limited by special or local conditions, as indicated under the several crop headings.

Alfalfa and red clover are used in rotations as cash crops, as crops to turn under for green manure, and as permanent cover crops in orchards. Soybeans, cowpeas, and velvetbeans are used in rotations as cash crops, as crops to turn under for green manure, and as crops to grow in combination or intermixed with corn. Sweetclover is used in rotations as a cash crop and as a crop to turn under for green manure. Lespedeza (fig. 1) is used as a cash crop in rotations and, to a limited extent, for green manure. Crotalaria (fig. 2) is used exclusively for green manure.

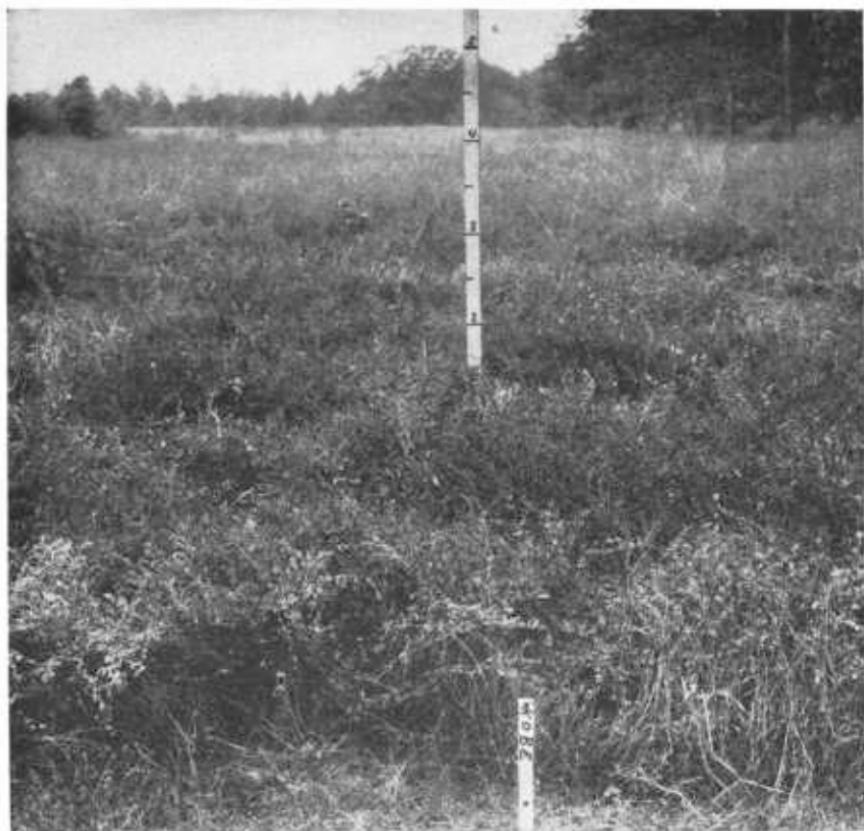


Figure 1.—Kobe, a variety of common lespedeza.

### NONLEGUMES FOR GREEN MANURE

Although legumes are generally recognized as the most desirable green-manure plants, nonlegumes, under certain conditions, may be used more profitably. When the period during which the green-manure crop can occupy the land is very short, as is usually the case in truck growing, the farmer wants a crop that will make the most growth in the time available. Under such circumstances, Sudan grass (fig. 3), another of the sorghums, or, in certain parts of the South, pearl millet often can be used.

In improving poor or worn-out soils, a nonlegume such as buckwheat sometimes serves better than any legume. For supplying organic matter to the soil, the crop that will produce the most growth in the time available should be chosen, whether a legume or a nonlegume.

### TYPES OF SUMMER GREEN MANURING

The use of summer green manure should be considered not only from the standpoint of increased crop yields, but also with reference to cash returns in connection with the crop that it is to precede or supplement. If a green-manure crop is to have exclusive use of the land for an entire season its use must be justified by the returns from increased crop yields in subsequent years. Sometimes it is possible



Figure 2.—*Crotalaria spectabilis* planted in wide rows.

to grow a green-manure crop and a cash crop the same season, but more often when a cash crop is grown every year it is necessary to obtain the green manure by interplanting with the main crop or using the residue of the main cash crop to supply the organic matter. The use of the words "green manure" in this way somewhat broadens the usual meaning, but the addition of organic matter to the soil in any way is in effect green manuring and must be considered in a discussion of the subject.

Under this broader definition of the term, four types of summer green manuring need consideration: (1) Using the crops exclusively for green manure, that is, the green-manure crop occupies the land the entire season to the exclusion of any other crop, (2) growing a green-manure crop intermixed with the main crop but subsidiary to it, (3) growing a green-manure crop in midsummer or late in summer following a cash crop, and (4) using legumes in rotation with other



Figure 3.—A heavy growth of Sudan grass.

crops and treating the stubble or aftermath of the legume as a green-manure crop.

General experience and the limited experimental data available indicate that the giving over of the entire crop season to the exclusive use of a green-manure crop is seldom profitable. This practice perhaps is justifiable only when the succeeding crop is more or less permanent and the establishment and good growth of the seedlings or young plants are of prime importance. Where early fall seeding of lawns can be practiced or is advised, a summer green-manure crop of soybeans, cowpeas, or other legumes can well be used to prepare the land.

In the South when a summer legume is plowed under early in fall it should be followed with rye or some other winter-growing crop to prevent the leaching of the plant food released in the decaying of the turned-under crop. When a summer green-manure crop is not followed by a winter crop, it should not be plowed under green but should be cut in the fall and allowed to remain on the surface as a mulch or should be lightly worked into the soil so as to delay decay and prevent loss during the winter months.

In northern latitudes there is relatively little leaching during the winter period, so it is seldom profitable to grow a crop merely to prevent this relatively small loss. A legume might well be sown to occupy abandoned or worn-out lands more or less permanently, and

where seed of a satisfactory legume is available at a reasonable price such a procedure is advised. In certain parts of the South lespediza and crotalaria can be used in this way.

When a noulegume, such as corn, is the main cash crop the use of a legume intermixed in the planting, or interplanted, will furnish valuable organic matter and in part have the effect of a crop rotation. Soybeans and velvetbeans are commonly planted with corn in this way in the Cotton Belt, and the practice is recommended (fig. 4).

Sometimes a green-manure crop can be planted in spring or mid-summer with or following an early cash crop such as wheat, oats, or some truck crop. Whether a crop thus grown can best be used exclusively for green manure or in part for forage and part for green manure will have to be determined by the probable cash value to the succeeding crops and the value of the forage that might be obtained.



Figure 4.—Corn interplanted with soybeans.

Where crotalaria is well adapted it can be used to advantage in this way for a green-manure crop. Broadcast seeding to oats late in spring will produce a good green-manure crop, which will in no way interfere with the growth or harvesting of the oats. When once established, the crotalaria will volunteer from year to year.

The use of legumes in rotation as one of the regular cash crops is a common practice and one of the most economical ways of maintaining soil fertility and crop production. The stubble of the legume returns to the soil considerable organic matter that is high in nitrogen and that costs practically nothing (fig. 5).



Figure 5.—Plowing under crimson clover and rye for soil improvement.

The annual lespedezas can be used with oats or other grass in the manner described for crotalaria, but the seeding should be done late in winter or early in spring. Using lespedeza and crotalaria in this way makes it possible to grow a cash crop the same year as the green-manure crop and insures soil improvement at little cost.

Lespedeza should be cut early, at first bloom or before, so that fall growth and reseeding will be assured. For maximum results the reseeding rate the first year should be 40 to 50 pounds per acre.

### INOCULATION

Artificial inoculation should be supplied when planting legumes on land that has not previously grown the crop, unless it is definitely known that the soil carries the necessary inoculating organism. Whenever possible, a small amount of soil from a local field that has grown a well-inoculated crop the previous year should be mixed with the seed, or 500 pounds per acre of such soil should be spread over the field prior to seeding. It is also advisable to use commercial cultures, which can be purchased through seed dealers. Directions for the use of such cultures will be found on the packages.

Florida beggarweed, cowpeas, Deering velvetbeans, crotalaria, lespedeza, alyceclover, hairy indigo, and common sesbania usually are naturally inoculated in regions to which they are climatically adapted.

Alfalfa and sweetclover generally are naturally inoculated in the western half of the United States but sometimes need artificial inoculation when being grown for the first time. In the eastern half of the United States inoculation is usually necessary when these crops are grown for the first time.

Soybeans should always be inoculated when first grown on a piece of land, but subsequent inoculation is seldom necessary. Red clover

seldom requires artificial inoculation because of the wide distribution of wild and cultivated clover.

### FERTILIZER

Whether commercial fertilizer should be used on a summer green-manure crop can generally be determined by observing the local practice with the same crop grown for immediate cash returns. Ordinarily heavy growth is desired in a green-manure crop, so when at least a fair growth cannot be attained without fertilizer a sufficient amount should be used.

### HARD SEED

Many summer legume crops contain a high percentage of hard seed or seed that will not germinate readily without scarification. All such seed should be scarified before it is planted if prompt germination is desired. A number of scarifying machines, all based on the principle of scratching or breaking the seed coat, are on the market. Scarification is accomplished in part when seed is threshed or hulled. Hullers with rasp cylinders and concaves usually scarify a high percentage of ordinarily hard seed.

A barrel, as described in Department of Agriculture Leaflet No. 107, The Barrel Seed Scarifier, or a concrete mixer has proved to be quite effective and often can be used conveniently when other means of scarifying are not available. Equal parts by volume of seed and stones, about three-fourths of an inch in diameter, should be placed in the barrel or concrete mixer and revolved slowly for about an hour. If the amount of gravel is increased, the time required for scarifying will be lessened. Each year before planting time, tests should be made to determine the amount of hard seed and the percentage of germination of the seed that is to be planted. Such tests will indicate in a few days whether or not scarification is necessary.

### SEEDING

General information regarding seeding is given in table 1. More specific information is given under each crop heading.

Common lespedeza, Korean lespedeza, alfalfa, sweetclover, and red clover should be seeded late in winter or early in spring. The other crops listed in table 1 should not be seeded until all danger of frost is past.

TABLE 1.—*Rate of seeding summer crops for green manure and soil improvement*

Crop	Quantity needed to plant 1 acre	
	Broadcast or in close drills	In 3-foot rows
	<i>Pounds</i>	<i>Pounds</i>
Alfalfa	15 to 20	3
Florida beggarweed	15 to 20	3
Buckwheat	35 to 50	8
Cowpeas	80 to 100	20
<i>Crotalaria striata</i>	15 to 20	4
<i>Crotalaria spectabilis</i>	20 to 30	6
<i>Crotalaria lanceolata</i>	12 to 15	3½
<i>Crotalaria intermedia</i>	10 to 15	3
<i>Crotalaria juncea</i>	30 to 35	7
Common lespedeza	15 to 20	3
Korean lespedeza	15 to 20	3½
Red clover	15 to 20	3
Common sesbania	25 to 30	4 to 5
Soybeans	60 to 100	20 to 25
Sudan grass	20 to 25	4 to 5
White sweetclover	15 to 25	3 to 4
Yellow sweetclover	15 to 25	3 to 4
Deering velvetbeans	100 to 120	25 to 30
Alyceclover	15 to 20	3
Hairy indigo	6 to 10	3 to 4

## DECOMPOSITION

A green-manure crop decomposes most readily in hot weather and when combined with moist soil. In warm weather with moisture present, almost complete decomposition may take place in less than 6 weeks. Young, succulent material decomposes much more readily than older or mature plants.

Fertility liberated in the process of decomposition should be utilized immediately by growing plants, or it will be lost by leaching or escaping into the air in the form of gas.

These facts should be kept in mind in utilizing green-manure and cover crops or any kind of crop residue.

## TURNING UNDER

A green-manure or cover crop may be left on the surface, or it may be combined with the surface soil by disking or plowing. When it is mixed with the soil, care should be taken not to leave the green-manure material in bunches or layers that will not decompose readily. Large quantities of undecomposed material will tend to make the surface soil dry and result in a poor seedbed and crop growth. When ample moisture is present, a crop completely turned under ordinarily will decompose more rapidly than one left on the surface or only partially turned under. Whether a green-manure crop should be completely turned under, partially combined, or left on the surface of the soil should be considered further in connection with (1) maturity of the crop, (2) time of year, (3) length of time that will elapse before the

growth period of the succeeding or cash crop, (4) nature of the succeeding or cash crop, (5) type of soil, and (6) moisture supply.

The crop should be turned down a sufficient length of time before an annual crop is planted to enable the material to pass through the first stages of decomposition in order that the plant food thus liberated may be available to the growing crop during its early development and rapid-growth period. Seeding a crop immediately after turning under a green-manure crop will sometimes result in injury to the young seedlings. In experimental planting it has been found advisable to let 2 weeks elapse before planting corn and 3 weeks before planting cotton. In the case of such a permanent crop as trees, exact information is lacking, but it is assumed that the green-manure or cover crop should be decomposed if possible just before the rapid-growth period.

Whether a green-manure crop should be plowed under or worked into the soil lightly in orchards depends somewhat on the activity of root growth of the trees at the time. If the roots are in active growth they should be disturbed as little as possible, but if dormant, deeper cultivation may be given.

Organic matter usually can be incorporated into heavy clay soils without serious danger of loss from leaching, since leaching in such soils takes place slowly. In sandy or porous soils leaching is rapid, so it is important to have the green-manure material nearly mature and to leave it at the surface so that decomposition and leaching can be retarded.

When ample moisture is present and the temperature is sufficiently high for plant growth, decomposition goes on rather rapidly under almost any soil condition. In general, however, decomposition is retarded by leaving the green-manure material on the surface or working it in lightly or partially.

Such other factors as the effect on crops of plowing or working the soil at certain times of the year must be considered in handling the green-manure crop.

### COMMON ALFALFA

Common alfalfa, a long-lived upright perennial, while primarily a hay crop, is valuable in crop rotation and is used effectively as a green-manure and cover crop. In the irrigated apple orchards of the Rocky Mountain and the Pacific Coast States it is being used with excellent results as a cover crop, and in the truck-crop areas of the Southwest it is popular for preceding or rotating with lettuce, cantaloup, or similar crops.

When common alfalfa is grown in an orchard, the entire crop should be allowed to remain for mulch or cover. It can be cut at intervals or allowed to stand and mat down. Orchards are often disked during the fall and winter months to reduce the fire hazard from accumulated dry material, incorporate some of the organic matter with the soil, destroy hiding places or nests of insects and rodents, and put the ground in shape to facilitate furrowing for irrigation.

In growing common alfalfa in orchards with trees under 4 years old, care should be taken to see that the trees get sufficient water and plant food. When the trees are older and more deeply rooted there is less danger in this connection. When common alfalfa is grown in orchards or elsewhere for green manure or cover, the time, rate, and method of seeding are the same as when the crop is grown for hay or other purposes.

## **BUCKWHEAT**

Buckwheat is a very old crop, used in Asiatic and European countries from very early times. In the United States it is grown mostly in the Northeast, Pennsylvania and New York having half the total acreage. It can be grown on poorer soils than most crops, does well on acid soils, and liming is seldom necessary. For these reasons it can sometimes be used in preference to other crops for adding organic matter to the soil.

Buckwheat is very sensitive to cold and is easily killed by freezing. Plantings in the northeastern United States should be made the latter part of June or early in July for best results. The rate of seeding should vary with the fertility of the soil. On rich soils 35 pounds per acre is ample, but on poor soils as much as 60 pounds per acre may sometimes be needed.

## **COMMON SESBANIA**

Common sesbania is native to North America and extends as far north as Alabama, Georgia, and Arkansas. In the southwestern part of the United States it occurs in abundance on the overflow lands of the Colorado River, and in Louisiana it is common in the rice fields.

In recent years this species has come into commercial use as a green-manure crop and is commonly known in the trade under the name "sesbania." Occasionally it is referred to as wild hemp, but this name should not be used, as the name "hemp" is commonly used for another class of plants. It is an upright annual legume attaining a height of 6 to 8 feet. In thin stands it is moderately branched, but in thick stands the lower branches either fail to develop or are shed very early and the upper branches are rather light and leafy.

While common sesbania is primarily a subtropical plant, it will mature seed as far north as Washington, D. C. Where sufficient soil moisture is available or when irrigation is supplied, it does exceptionally well in the Southwest, where the atmospheric humidity is very low. It does not thrive so well in the Southeast, where the rainfall is comparatively heavy and the atmospheric humidity high. This difference may, however, be due more to soil than climatic difference, as the soils of the Southwest are very fertile. Common sesbania makes little growth in cool weather but grows very rapidly at high temperatures. In northern latitudes slow growth and small yields are to be expected.

Available information indicates that common sesbania does best on rich loam soils. It will grow on poorer land, but it has not done well in limited tests on poor sandy soils.

The only use made of common sesbania is for green manure. It seems to be disliked by livestock and, so far as known, has no value as forage. In the Imperial and Coachella Valleys of California and in the Yuma and Salt River Valleys of Arizona, common sesbania is used for green manure in connection with winter truck crops. It is also adapted to the irrigated lands of the lower Rio Grande in Texas. On account of its rapid growth and the heavy tonnage produced, this crop seems well suited for green manure where the land can be given over to this purpose during the midsummer season.

The seed of common sesbania is comparatively small, and 20 pounds per acre should be sufficient under average conditions. The seeding may be done by broadcasting or drilling, but the latter method is more economical and usually gives better stands.

It is not uncommon to find nematodes in the roots of common sesbania, but they do not seem to do serious damage to the plant. In fact, plants with nematodes are often strong and vigorous. While little or no damage may be done to common sesbania, succeeding crops may be attacked by the nematodes, and this must be considered in growing any crop that may be subject to their attack.

As the organism that inoculates common sesbania seems to be rather commonly distributed throughout the South, artificial inoculation is unnecessary.

### COWPEAS

Cowpeas are one of the summer crops most commonly used for green manure in the Southern States. The plants are viny or semiviny, depending on the variety, and are fairly leafy. Under most conditions, cowpeas make a good yield of green manure in comparison with other crops and are also valuable both as a forage and seed crop.

Adapted to a wide range of soils, they apparently do as well on sandy soils as on clays. Among the best varieties for use in the South are Iron, Victor, Brabham, and Groot. Seeding should not be done until the ground is thoroughly warmed, as all varieties are susceptible to cold. When planted in rows 3 feet apart, about 20 pounds of seed per acre are required, and when sown broadcast, 80 to 100 pounds per acre are needed. Cowpeas are subject to attack by nematodes, bacterial canker, and fusarium wilt, all of which often do considerable damage.

If cowpeas have been grown in a locality for many years, the inoculating bacteria are plentiful, and inoculation is usually not necessary. In new regions, however, especially in the North and West, when cowpeas are grown for the first time, the soil should be inoculated.

### CROTALARIA

Three species of *Crotalaria* have been used for green manure in the United States—*C. spectabilis*, *C. intermedia*, and *C. striata*. *Crotalaria lanceolata* and *C. juncea* have given good results in experimental plantings. Other species with similar habits have value for this purpose and are used in other parts of the world.

All these species behave as annuals in the United States except under almost frostless conditions. They are upright and attain a height of 3 to 6 feet. A warm season is necessary for their best development. They do not start growth until late and make most rapid growth during July and August. *Crotalaria* is especially adapted for sandy land. The seed should be planted late in spring, 15 to 30 pounds per acre. The latter quantity should be used, especially when the seed is not scarified or when seeding conditions are unfavorable.

Artificial inoculation seems to be unnecessary under ordinary conditions. *Crotalaria* has been used most extensively in the citrus and tung tree plantings in Florida and Mississippi, but it has also been used in pecan orchards of the Gulf coast area and for general plantings elsewhere. The yield of green manure is comparatively heavy, the plants decompose readily, and the crop seems well adapted for cover and green-manure purposes. As the percentage of hard seed is usually high the seed should be scarified before being planted.

In the lower South, *crotalaria* can be seeded in oats late in spring and allowed to grow after the oats have been harvested. In this way a good green-manure crop is assured at little expense. The cro-

talaria will make little growth before the oats are mature and will in no way interfere with harvesting. The oats serve as a nurse crop, keeping down weeds that otherwise would compete with the crotalaria during the early and most critical period of its growth.

### **FLORIDA BEGGARWEED**

Florida beggarweed, an annual, upright, herbaceous plant, attaining a height of 4 to 7 feet, is a native of tropical and subtropical America, occurring as far north as the southern part of the United States, especially in cultivated lands. The plant is leafy above, but sparingly so below, and the main stem is sparsely branched. In thick stands the branches are greatly reduced or fail to develop.

In Florida and as far north as southern Georgia and Alabama, it has been used as a regular and volunteer crop. Attempts to grow the crop at a few northern experiment stations indicate that under favorable conditions it will make a fair growth as far north as the Great Lakes States, but in northern latitudes it can seldom compete with summer weeds.

Florida beggarweed does best on a rich sandy loam soil but is not exacting in its requirements. It is of particular interest and value on account of its ability to grow on soils that are moderately acid. A moderate rainfall is essential to good growth even though the plants will stand as much drought as the average farm crop. On extremely poor sandy soil it will do but little unless supplied with commercial fertilizers; on cotton and corn lands that have been regularly fertilized, little or no fertilizer is needed; on lands not previously fertilized, 200 pounds of superphosphate, 75 pounds of muriate of potash, and 50 pounds of sodium nitrate or sulfate of ammonia can be used to advantage.

For green manure, Florida beggarweed serves best on sandy loam soils in rotations where a volunteer crop can be handled. When once established it will volunteer from year to year if seed is allowed to mature. Volunteering can be accomplished by permitting strips through the field to go to seed each year and then harrowing cross-wise to scatter the seed, relying on subsequent plowing and cultivating to cover it. While good stands will not always result from this procedure, it is often economical. Florida beggarweed does not reseed well except on cultivated land. Cotton growers sometimes object to this volunteering habit, as the mature seed of Florida beggarweed adheres to the lint of the cotton.

Seeding of Florida beggarweed should be delayed until all danger of frost is past, May 15 to June 20 in the extreme South. It can be sown in early corn at the time of the last cultivation. Hulled seed should be used when an immediate stand is desired. Unhulled seed will not germinate readily on account of the high percentage of hard seed it contains. When hulled seed is used, 15 to 20 pounds per acre of scarified seed is sufficient on a good seedbed. If unhulled seed is used, this should be increased to 30 to 40 pounds per acre. As the organism that inoculates Florida beggarweed seems to be present in most southern soils, artificial inoculation is unnecessary.

### **LESPEDAZA**

Common lespedeza is an annual spreading or upright leguminous plant attaining a height of 6 to 12 inches on poor soils and at least

12 to 18 inches on fertile soils. The stems are small, branch freely in thin stands, and are quite leafy. It is well adapted to the Southeast and is found as an escape throughout the Piedmont and Coastal Plains areas, extending north to and beyond the Ohio River and west beyond the Mississippi River. It is in this general region that the crop is most valuable.

For soil improvement, common lespedeza offers great possibilities. It may be used for green manure, hay, or rotating with other cash crops.

While common lespedeza makes little growth until warm weather and continues growing until fall, it must be seeded early to get good stands. The seed should be sown either broadcast or in close drills, between January 15 and March 15, at the rate of 15 to 20 pounds per acre. When the plants are allowed to stand sufficiently late to mature seed, a volunteer growth will be maintained from year to year. The root knot nematode attacks common lespedeza and on dry sandy land may do serious damage. The organism that inoculates common lespedeza seems to be rather widely distributed, and artificial inoculation will seldom be required.

There are two improved varieties of common lespedeza, known as Kobe and Tennessee 76. Both grow larger than the common form and are preferred for use under cultivation.

Korean lespedeza is like common lespedeza in general but differs in its range of adaptation, season of development, and minor plant characteristics. It cannot be used successfully as far south as can common lespedeza, but it has a somewhat farther northern range. It is an earlier maturing, slightly larger growing plant than common lespedeza, with practically identical utilization.

Sericea lespedeza is a hardy perennial plant similar in growth to alfalfa. It will grow on soils of greater acidity and lower fertility than most other crops and has greatly increased the yields of crops that it precedes. For controlling erosion on poor acid soils and increasing the soil fertility there is no crop superior in the region in which it is adapted. Generally sericea is adapted to the same region as Korean lespedeza, but its current use is much more limited.

### **RED CLOVER**

Red clover has long been known as a valuable crop for soil improvement. It is commonly used in crop rotations, often as a summer green-manure crop, and also as a combination hay and green-manure crop. The early or first growth is cut for hay and the later or second growth used for green manure. Another way of handling it is to cut the first crop for hay, then harvest a seed crop and return the straw to the land. When only the stubble is left in the fields the soil will benefit from the nitrogen gathered by the nodule-forming bacteria that live on the roots. The fact that red clover has upright growth and heavy yields, together with its fitting so readily into rotations with other crops, makes it one of the best crops for soil-improvement purposes.

In most regions red clover is seeded in the spring, 15 to 20 pounds of seed being used per acre. Because red clover has been grown over such a wide area, the organism that inoculates it is usually in the soil. In new areas, however, artificial inoculation is necessary.

## **SOYBEANS**

The soybean is an upright legume native to northern China and introduced into the United States early in the nineteenth century. While the crop is grown primarily for seed, it is used extensively for forage and soil improvement. In the United States it is grown mostly east of a line passing through the middle of the Dakotas and south through central Texas. When soybeans are used for a green-manure crop, late-maturing varieties will usually give the largest yields. When they are used as a regular crop in rotations, varieties should be selected that will give high yields of seed or hay, as the grower may desire. For green manure the crop should be sown broadcast or in close drills, from 60 to 100 pounds of seed being used per acre, depending on the size of the seed, which varies with varieties. When soybeans are sown on land where the crop has not been previously grown, inoculation is advisable, otherwise it is unnecessary.

## **SUDAN GRASS**

Sudan grass is an easily grown nonlegume whose habit of rapid growth makes it a suitable plant for green manure when the period in which such a crop can be used is very short. Sudan grass belongs to the sorghum group, but it is only moderately coarse and is adapted to practically all parts of the United States. The stems are upright, attaining a height of from 3 to 5 feet and a diameter equivalent to that of an ordinary lead pencil or less. Such a plant is especially serviceable in connection with truck-crop growing where the summer period between crops must usually be short.

The seed should be sown in close drills or broadcast, 20 to 25 pounds per acre. The time of turning down should be determined with reference to the time of planting the succeeding crop and not to the stage of development of the Sudan grass. Ordinarily very succulent Sudan grass will decompose rapidly, and a short period after its turning under the soil will be in condition to receive the succeeding crop. When the plants are more mature, a longer time is required. Mature Sudan grass plants turned into the soil will reduce the available nitrates for a time, so it cannot be used as green manure unless ample nitrogen fertilizer is applied or a long period can elapse before it is necessary to use the land.

In the humid region of the Central and Southeastern United States, Sudan grass is subject to serious damage by foliage diseases. Much of this can be overcome by using a recently developed variety known as Tift Sudan. This variety is especially valuable in the Southeastern States.

## **SWEETCLOVER**

There are two species of sweetclover that are used as summer green-manure crops in the United States—white and yellow. They are upright-branching, leafy, biennial legumes in thick stands having the appearance of alfalfa. The first year of seeding they make a growth of 12 to 24 inches, depending on moisture and soil conditions, and in the second year reach a height of 4 to 5 feet. Both of these species need lime and for this reason cannot be grown successfully in most parts of the eastern half of the United States unless it is supplied. In the Corn Belt, white sweetclover has been especially useful as a soil-

improving crop. Large increases of corn and other crops have followed its use as a green manure and hay crop in rotations.

Inoculation is one of the important factors in success with both white and yellow sweetclover. In the alfalfa region west of the Mississippi River, wherever alfalfa inoculates naturally, these crops will not need artificial inoculation, but in most areas east of the Mississippi River it is essential. The seed should be sown on well-prepared firm ground, 15 pounds of scarified seed or 25 pounds of unscarified seed per acre. Seeding can be done any time from fall to early in spring. In fall or winter unscarified seed should be used, but in spring scarified seed gives the best results. Spring broadcast sowings should be covered with a harrow, but fall or winter sowings should be broadcast and given no further treatment. The heavy top growth and large deep-penetrating roots make both these crops excellent for green manure.

### **DEERING (FLORIDA) VELVETBEANS**

The Deering (Florida) velvetbean is a vigorous-growing leguminous annual plant that, under favorable conditions, attains a stem length of 40 feet or more. Most varieties are viny, but a bush form has been developed. It is semitropical, adapted only to the southern part of the United States. While Deering velvetbeans make excellent feed for livestock, when cut in bloom they are difficult to handle for hay and are seldom used for this purpose. They are grown for the seed crop, however, and are used in rotations to improve soil. Velvetbeans are one of the best crops for sandy lands and for maintaining fertility. Because velvetbeans are hardy, yield heavily, and decay readily, they make an excellent green-manure crop.

The Deering velvetbeans should not be sown until the soil is well warmed, or a little later than the time for planting corn. Seeding in wide rows is recommended and will require from 25 to 30 pounds of seed per acre. As the organism that inoculates Deering velvetbeans is present in the soils of the South, artificial inoculation is unnecessary. The root knot nematode does no damage to this crop. When the beans are grown for seed it is essential to plant them with a supporting crop, such as corn, to insure a free circulation of air and to prevent the flowers from decaying without setting seed.

### **ALYCECLOVER**

Alyceclover has only recently come into use as a cover and soil-improving crop, but it has attained some importance for this purpose in the citrus and tung groves of Florida. It is a low-spreading summer annual legume, with stems more erect in thick stands and attaining a length of 2 to 3 feet. In addition to its use as a cover crop, alyceclover makes good hay and pasturage. It is seeded late in spring, 15 to 25 pounds of seed used per acre. Inoculation is not necessary, as the proper inoculating organism seems to be in all soil where alyceclover is adapted. On some soils the application of superphosphate and potash is necessary, and on practically all soils increased plant growth will result from their use. On soils that have grown alyceclover for several years, nematodes may do serious damage. According to present information alyceclover can be recommended for the extreme southern part of the Cotton Belt only.

## KUDZU

Kudzu is an excellent soil-improving legume and can be used in rotations for this purpose. It is a long-lived perennial, however, and should be left for a number of years before being plowed under in the rotation. Large increase in yields of subsequent crops has followed the use of kudzu, and it can be grown to advantage in many places where other legumes do not do well. Kudzu is adapted to the same general region and conditions as lespedeza, making its best growth in the region south of the Ohio River and east of the Great Plains. It is recommended for gully erosion control and will prevent soil washing when used as a hay crop. As a hay and pasture crop it is recognized as being equal to alfalfa in feeding value but is somewhat more difficult to handle on account of its vining habit.

## HAIRY INDIGO

Hairy indigo, recently introduced into the United States, is an upright branching legume native to tropical Asia, Australia, and Africa. Small commercial plantings have been made in Florida, where it has proved of value both as a forage and a soil-improving crop. It is a summer annual, attaining a height of 4 to 7 feet, with moderately coarse stems becoming woody with age and leaves that somewhat resemble vetch. Two distinct types are recognized—a large late-maturing strain and a smaller one that matures about a month earlier. The late strain matures seed in November and is adapted to the southern half of Florida. The early strain that matures in October is adapted as far north as the southern half of Georgia.

Hairy indigo has a comparatively low lime requirement, grows fairly well on moderately poor sandy soil, is highly resistant to nematodes, and has always been naturally inoculated. It makes good growth and matures sufficient seed in Florida to volunteer a satisfactory crop in corn after the last cultivation. Fertilizer requirements have not been definitely determined, but appreciable growth increase has resulted from applications of superphosphate and potash. Three hundred to five hundred pounds per acre of an 0-14-10 or 0-10-10 fertilizer, or its equivalent of phosphate and potash, are suggested.

Seedings can be made from March until the last of May, but early seeding is preferred. Three to four pounds of seed per acre are used when drilled in close drills and six to ten when broadcast in a well-firmed seedbed. The smaller quantities are recommended when the crop is grown for seed and the larger when grown for forage or green manure.

## WEEDS

Weeds are usually thought of as plants that should be destroyed, but much of the vegetation that is commonly termed weeds contributes large quantities of organic matter to the soil. Whenever weeds can be utilized for green manure without sacrificing needed ground moisture and plant food, their presence can be an advantage rather than a detriment.

U. S. GOVERNMENT PRINTING OFFICE: 1947

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